Northeastern Forest Experiment Station

Upper Darby, Pa.

QUARTERLY REPORT ON

FOREST INFLUENCES AND FLOOD CONTROL SURVEYS

July 1, 1951

FOREST INFLUENCES

by H. C. Storey

GENERAL

During the past quarter an investigation was made of the White Mountain area in New Hampshire to determine what research is needed to help solve watershed management problems of the area. This rugged mountain area drains into four important river basins: Connecticut, Merrimack, Saco, and Androscoggin. The area lies largely in the White Mountain National Forest and is of great importance as a water-yielding area, timber-growing region, recreational and wildlife area. The big problem is to realize the full multiple-use potentialities without jeopardizing the water resource.

Surface and ground-water supplies are obtained from the mountain area for domestic uses by a large number of communities. Some of these communities are faced with the need for developing additional supplies to take care of the heavy requirements during the peak of the tourist season. Water for this use must be of good quality and in sufficient quantity through the driest part of the year when use is the heaviest.

A large amount of water from the White Mountains is used by industries requiring water of low turbidity. These industries (largely paper companies) require assurance of adequate supplies throughout the year.

New Hampshire has the highest developed hydroelectric capacity per square mile in the country (32 kilowatts per square mile). Few hydroelectric sites remain which are economically feasible for further power production. Power demand far exceeds that obtainable from hydroelectric sources, steam plant generation must make up the deficit. This had resulted in a relatively high cost for electric power in the state. Any

measures in the watersheds producing a more uniform condition of stream flow would help greatly in improving the efficiency of hydroelectric development. For example: The Merrimack River Basin contains a total installed hydroelectric capacity of about 62,000 kilowatts. This production capacity can only be realized during a small fraction of the year, under optimum conditions of water. There are times when, because of water conditions, only about 28,000 kilowatts can be produced.

Approximately 84 percent of the land area of New Hampshire is forest land. Thus, the growing and harvesting of timber crops will continue to play an important part in the general economy of the state. It is imperative that cutting practices designed to build up the forest stands and maintain them at their full productive level also include measures that will promote and maintain good hydrologic conditions within these important watershed areas. It is further important that logging operations be so designed as to insure that no accelerated erosion is started, and that logging roads and trails be left in such condition after logging is completed as to prevent concentration of water and erosion of the exposed soil surface.

Research is needed to determine the effect of different cutting practices upon volume and time of water yields. In addition, studies should be carried on to establish guides in the location, surface drainage and after-logging care of roads and skid trails.

DELAWARE BASIN RESEARCH CENTER

by Irvin C. Reigner

Weather

Precipitation on the Dilldown Watershed has continued at an abnormally high rate. Normal annual rainfall for this locality is between 45 and 50 inches and in previous years rainfall measured at Dilldown fell within this range. For the hydrologic year October 1, 1948 to September 30, 1949, total rainfall measured 48.92 inches. During the year 1949-1950, 45.08 inches were recorded. So far this year, however, with three months still to go, rainfall already amounts to almost 48 inches. We are fortunate to have this extreme weather condition within the calibration period of the watershed.

Stream Flow

A record peak discharge from Dilldown Creek was recorded on March 30. Stream flow attained the rate of slightly over 100 cubic feet per second, following a rainfall of 3.75 inches during the previous 2½

days. Considering the relatively small drainage area, 2.39 square miles, this rate of discharge is quite high. Yet, no bed load or sediment accumulation was in evidence following the storm.

Interception and Stem Flow

The installations made last summer at Dilldown were reactivated with improvements early in Spring before the vegetation came in leaf. Thus, data will be collected this year under a range of vegetative conditions. Since then, additional installations have been made which will yield data on other variables. Two of our original installations were in medium size scrub oak, 3 to 5 feet tall, with a moderate density. Both interception and stem flow equipment has now been installed in scrub oak sites having larger brush, 5 to 8 feet tall, and with high density. Additional stem-flow equipment has been installed in the swamp area on trees ranging in size from 2.7 to 19 inches, d.b.h.

Interception installations at the Pocono Experimental Forest have also been reactivated and will be supplemented by stem flow equipment as soon as possible.

Soil Moisture Losses

Work has been continued in our efforts to correlate soil moisture losses with climatic data. This study was described in the preceding quarterly report.

Numerous additional variables and interactions of variables have been tested since then. A new equation, giving the closest correlation to date, has been developed:

$$L = 0.02 + 0.01T/PS + 0.67S$$

in which L = loss in soil moisture in inches per day; T/PS is a ratio combining the length of time elapsing from the last rain of 0.02 inches or more and the product of the amount of rain and saturation deficit. The time is expressed in hours elapsed from the end of the rain to the middle of the period under consideration. Precipitation (P) is expressed in inches multiplied by 1000. Saturation deficit is expressed in grains; S = Saturation deficit, expressed in grains and based on the daily average of temperature and relative humidity readings taken at two-hour intervals on the hygrothermograph.

The use of this equation gives results which are within 20% of the true daily soil moisture losses. However, in the data used in the analysis two estimates were highly divergent from the true losses, and the reason for the large discrepancies could not be determined. Thus, further work is necessary to perfect our equation.

We are now measuring soil moisture daily and believe greater accuracy will be obtained in this factor. In addition, daily estimates of cloud coverage are being made as an added variable which may affect evapotranspiration rates.

Root Penetration Study

Supplementing the previous soil survey at Dilldown, a study was made during the period for the specific purpose of determining maximum root penetration.

Observations of root depth, made during the original survey, indicated that plant roots did not penetrate below a depth of 18 inches. However, in analyzing soil moisture losses it became apparent that soil moisture was dropping below field capacity at depths from 24 to 27 inches, the depths of the deepest Colman units. Since moisture losses due to evaporation do not generally reach these depths, transpiration was the apparent cause and root penetration to or below 24 to 27 inches was indicated.

The new study confirmed this indication. Deep pits were dug and roots were followed to their end. Soil samples were taken at regular intervals and examined with a magnifying glass for the presence of minute roots and root hairs. It was found that scrub oak penetrated to a depth of 40 inches, while pitch pine and red maple send roots to 44 inches.

Although root penetration has been found to reach the above depths, it is true that almost all roots are within the upper 18 inches, and that root development below 2 feet is rather negligible. Thus, it is believed that our estimates of soil moisture losses are nearly exact, although we plan to place additional Colman units at the lower depths.

Scrub Oak Conversion

Seaman Tiller Project

Immediately following the disappearance of concrete frost, the Seaman Tiller hired by the Pennsylvania Department of Forests and Waters began treatment of an 8-acre area adjoining Dilldown Watershed. Site preparation by the Seaman Tiller, which knocks down scrub oak brush, chops and cuts it into the mineral soil along with the humus layer, was under study as an improved method of treating scrub oak areas prior to planting.

Practical and theoretical advantages of th Seaman Tiller over cutting furrows with a bulldozer include -

1. A much neater appearance of the planting area plus less chance of soil washing due to the flat swath resulting from the Tiller treatment.

2. Possibly higher fertility and greater moisture holding capacity of the treated area due to the incorporation of organic matter into the mineral soil.

3. Less frost, and thereby less likelihood of frost heaving, due also to the above reason.

These advantages appear to be offset by the high cost of treatment of the site selected for the study. Although the machine was designed to be rugged enough to rip up blacktop highways in preparation for resurfacing, the amount and size of rocks in the soil slowed the operation of the machine excessively. Not only was the amount of treated area per hour considerably less than expected, but the rocks slowed the rotor blades to the extent that the effectiveness of the machine was decreased. Adequate treatment was obtained only after treatment of the same area was repeated one or two times.

The study was designed to test the number of treatments necessary; areas were laid out to compare once-over treatment with twice-over and thrice-over treatments. From general observation the once-over treatment did not appear to be adequate either in preparing a proper planting medium or in removing competing vegetation.

From similar jobs done elsewhere in the locality by the same machine, indications are that a much faster and more thorough treatment was accomplished on sites with similar brush cover but relatively free from rocks. However, the site selected for the study was as typical as possible of the cover and rock conditions encountered on the watershed.

Following the site treatment, planting began immediately. Japanese larch, red, jack, and pitch pines--species showing promise in previous planting studies--were planted in addition to hybrid and oriental chestnuts and hybrid poplar. A standard fifty-clone test of hybrid poplar was installed late in May. This work was delayed as long as possible to allow settling of the treated area and to apply lime to 2 of the 4 replicate blocks.

An establishment report including cost data is in the process of preparation by the Pennsylvania Dept. of Forests and Waters.

Natural Regeneration Study

A second annual examination of bulldozed strips designed to encourage natural regeneration in scrub oak areas was made in June. These

strips were prepared in the fall of 1949, coinciding with a heavy seed crop on pitch pine and are merely three blade-wide strips cut into mineral soil and lying to the leeward of a group of pitch pine seed trees.

Examination entails covering each strip completely and counting the total number of seedlings found. Most of the seedlings found previously have survived and, in fact, a somewhat greater number of seedlings were found this year than in the first examination. Conclusions, however, are essentially the same for both examinations:

1. Seventy percent of the seedlings are within 100 feet of the seed source and are distributed fairly evenly within this distance. The remaining 30 percent are scattered from 100 feet to 240 feet from the seed source.

2. Within the first 100 feet of strip, an average of about 600 trees per acre were found.

The number of seedlings established is hardly enough to provide a well-stocked stand. However, the method shows promise in that no seedlings could be found in the adjacent untreated brush. With an adequate seed source, it is most likely that a well-stocked stand would be obtained.

Supplementing this study, three feet of each eight-foot strip was given an application of lime. The average pH of the untreated soil is about 4.5; enough lime was applied to raise the pH to about 5.5 according to the available information. Examination and subsequent analysis shows no effect of the liming on the number or size of seedlings. An acidity test was made this Spring on both the treated and untreated areas and it was found that both are in the same pH class, 4.5 to 4.6. Although it is possible that the effect of the lime has been lost by this time, it is more likely that not enough lime was applied initially.

Miscellaneous

As part of its quarterly meeting, the Pennsylvania Council of the Water Resources Division of the U. S. Geological Survey visited Dilldown Watershed on May 9. The research center staff participated in a show-me trip for this group of about 15 engineers and geologists. Considerable interest was evinced in the overall project and in the individual installations.

Dr. Harper and Mr. Correll spent two days with us while conducting an inspection of the Research Center.

Donald J. Close, a recent graduate in forestry from Penn State, has been hired as a field assistant.

MOUNTAIN STATE RESEARCH CENTER

by George R. Trimble, Jr.

Fernow Experimental Forest

Watersheds.--Installations have been completed on all five of our watersheds. Precipitation and runoff are being recorded continuously.

Beginning in July, water quality measurements will be made periodically to obtain values for turbidity, water color, odor, pH, dissolved, suspended and total solids, and hardness. These water qualities will be related to season of the year and to stream stage during the calibration period. After the watersheds have been treated, an attempt will be made to correlate the factors of water quality with type of treatment. Water analysis will be made by the West Virginia State Water Commission under a cooperative agreement.

Skid-road erosion study.--A study of skid road erosion has yielded some preliminary information. This study is being carried out on a limited scale in two areas.

Area #1: The study area is composed of four 5-acre plots. Each plot was logged under a different cutting practice level; i.e., a different intensity of forest management with different skid road location and drainage standards. The area was logged during the early winter of 1949.

The soil is a silt loam derived in large part from limestone.

Permanent stations for the measurement of road profiles were established in February 1950, immediately after logging. These profiles, or cross sections, were remeasured one year later and the amount of skid road erosion that had taken place in the first year after logging was computed. Remeasurements will be made annually until all accelerated erosion from these roads had stopped. It should then be possible to determine, for this and similar areas, the trend of erosion following logging. This will include the rate of erosion decline as well as the total amount of soil lost from the end of logging until erosion materially ceases.

Our data show a definite trend indicating that increased slope percent and increased slope distance are the factors which most strongly favor skid road erosion. A more intensive analysis of present data as well as more actual field data are needed before definite quantitative relationships can be established between these factors and soil loss.

The figures below show in general the first year trend of erosion.

Slope (Percent)	Distance Below Drainage Outlet (feet)	Number Cross-Sections Measured	Soil Loss (Cubic feet soil per 100 lin. ft. of skid road)
0-20	0-132	13	44
0-20	132-264	0	---
21-40	0-132	23	70
21-40	132-264	5	104

Area #2: Three representative skid roads were selected for erosion study in a 53-acre compartment which was logged for bulk products under a fair type of forest management. Logging was done during the winter of 1950-1951.

The soil type is a silt loam derived from sandstone and shale.

Permanent stations for measuring the skid road profiles were established so that the amount of soil lost during logging could be determined as well as that lost subsequently.

On one of the three skid roads, water bars were put in after logging. Distances between bars averaged about two chains. The other two skid roads were left without drainage provisions of any kind.

Three measurements have been made at these stations: (1) before logging, (2) immediately after logging, and (3) three months after logging.

Slope percents were measured on all three roads. On the one road where bars were installed, distances were measured between the profile stations and the nearest water bar above.

Average loss from these roads during skidding amounted to 304 cu. ft. of soil per 100 linear feet of skid road. During the first three months after skidding--March, April, and May--an average of 129 cu. ft. of soil per 100 lin. ft. of skid road was lost on the two roads without drainage. On the road with bars, the average loss for this period was 55 cu. ft. per 100 lin. ft. of skid road.

The data will be analyzed to show the effect of steepness and length of slope on erosion. Intensity of use during logging, as indicated by slope position, will be studied as a factor influencing soil loss.

Profile remeasurements will be made as in Area #1 as long as

erosion continues.

Eventually the erosion study should provide a guide for skid road standards; i.e., grade and road drainage provisions. In addition, by experimenting with different types of water bars, we hope to determine the most efficient type.

FLOOD CONTROL SURVEYS

by Arthur Bevan

GENERAL

Precipitation averaged about 40% above normal during April for the Northeastern region. During May and June precipitation was generally 20% below normal. In New York and central New England light rain combined with above normal temperatures produced a temporary drought which retarded crops and caused forest fire hazard conditions. Heavy precipitation near the end of June eliminated forest fire danger and produced favorable growing conditions for crops.

Runoff was above normal for April and below normal for May and June. Heavy precipitation produced local flash flood in north central West Virginia on June 13. Heavy rains during the last week in June brought many streams in New York and Pennsylvania to bankfull stage.

SURVEY ACTIVITIES

The final draft of the Connecticut report has been completed and is ready for transmittal to Washington. Tentative drafts of the Merrimack and Salt River reports have also been completed and will be reviewed by local agencies during July and early August. The computation of the effect of lack of control of forest practices has been made on all three watersheds.

Major emphasis has been placed on collection of damage and land use data in the New England-New York River Basins during the last 3 months.

STATUS OF FLOOD CONTROL SURVEYS

Connecticut River.--Completed and forwarded to Washington for final approval.

Merrimack River.--Tentative draft prepared.

Salt River.--Tentative draft prepared.

Allegheny, Upper Susquehanna, and Monongahela Rivers.--No further progress.

COOPERATION WITH SOIL CONSERVATION SERVICE

New England-New York area.--Cooperative arrangements have been made for distribution of survey funds in accordance with job responsibilities on forest and open land and to divide field survey work on damage appraisals and other over-all basin projects. A revised survey work outline has been prepared jointly with SCS and submitted to Washington.

Roanoke River report.--The tentative draft of the Roanoke River report is being reviewed and the effect of lack of control of forest practices determined in order to adjust woodland program costs and benefits.

PERSONNEL

Bert Husch has resigned to accept a position at Ohio State.

Lem Miller of our Hydrology Staff has transferred to the Corps of Engineers, Jacksonville, Florida.